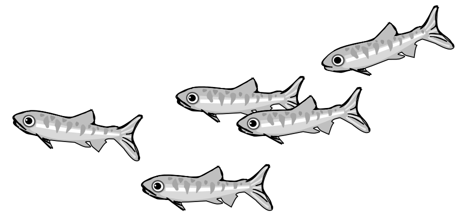
US Army Corps
of Engineers
North Pacific Division

Salmon Passage Notes

Snake and Columbia River Fish Programs

February 1996

Fish Research:
Filling the Gaps



As the Corps carried out flow, spill, transport and other operational measures for fish this past year, researchers at the dams gathered data to provide better information on fish behavior. Their efforts will help the region make long-term choices on how best to reconfigure the lower Columbia and Snake River dams to improve salmon survival.

Under the National Marine Fisheries Service (NMFS) biological opinion, the Corps and the region have embarked on a multi-year plan to coordinate research on salmon survival, with studies of long-term structural modifications to the dams for fish (April 1995 Salmon Passage Notes).

The research covers a number of topics: surface bypass prototype testing, collection of biological baseline data needed to evaluate potential reservoir drawdowns, continued evaluation of the effectiveness of juvenile fish transport, and dam passage improvements.

Testing surface attraction devices

The concept of passing juvenile salmon at the mainstem dams by means of surface oriented systems has drawn wide attention in the region. Such a system would take advantage of juvenile fishes' propensity to travel in the upper portion of the water, and their attraction to currents. Surface bypass might guide a large percentage of fish away from the turbines and use a relatively small amount of spill to get them past the dam.

Results of prior testing of this concept at Wells Dam (Douglas County Public Utility District) on the mid-Columbia River had been encouraging.

Because of the design of the Wells Dam, the spillways are located over top of the submerged powerhouse turbines, causing a surface bypass effect. Fish are attracted to the current created by the turbines, but simply pass over the spillway rather than diving down, or "sounding," to the turbine openings. In some tests, over 90% of the juvenile fish were surface-bypassed through the spillway at this "hydro-combine" type of powerhouse.

At Corps-operated dams, the spillways are next to, rather than over, the powerhouse. When the powerhouse is operating, the turbines create a stronger current and attract juvenile fish; when water is instead passed over the spillways, the fish follow that current.

The Corps initiated field testing of surface attraction devices designed to test the concept of surface bypass at two dams this past spring and summer.

Structures with either vertical or horizontal slot entrances were installed in front of spillways, ice and trash sluiceways, and turbine intakes at Ice Harbor and The Dalles dams, to create an attraction current. Juvenile fish migrating through the reservoirs en route to the ocean, would hopefully detect the current as they approached the dams, and pass through the slotted entrances rather than sounding to the much deeper turbine intake entrances. Hydroacoustic and radio-tracking methods were used to monitor juvenile fish movement as they approached and entered the slots.

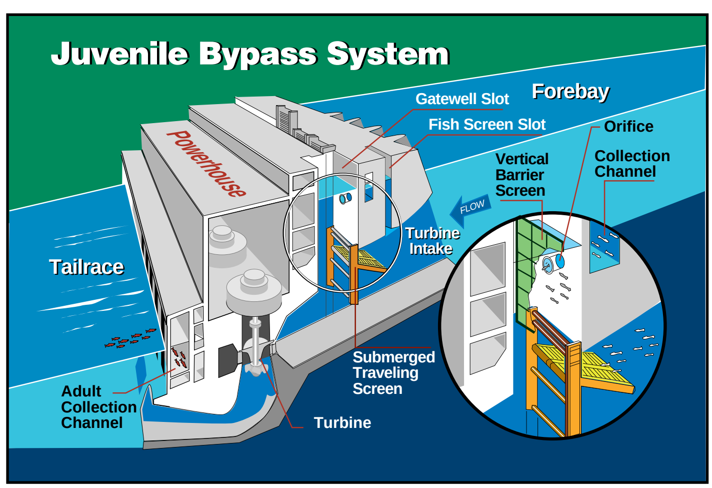
In the Ice Harbor study, data suggested that the horizontal slots at the sluiceway in front of the powerhouse were more effective at attracting migrating juvenile fish. An estimated 25 percent of the radio-tagged fish passed over the spillway and 53 percent passed via the sluiceway.

In a similar investigation at The Dalles Dam, researchers monitored the movement of radio-tagged juvenile spring and fall chinook salmon. A test surface collection device was installed at the ice and trash sluiceway, and surface flow stoplogs were installed at a spill bay.

Nearly 88 percent of the fish used the spillway route, probably because a majority of the total river flow—typically over 60 percent—was being spilled for fish passage. Because so many juvenile fish passed over the spillway, limited data was collected on the sluiceway surface bypass device.

Evaluating existing juvenile fish bypasses

The Corps continues to test and install extended-length turbine intake screens to guide fish into the existing juvenile fish bypass systems. In these systems, juvenile fish following currents to the turbine area are guided away from the turbine intakes by huge screens. The extended forty-foot



screens are intended to increase the percentage of fish guided away from the turbine intakes and through the bypass channel.

In tests at Lower Granite Dam, researchers determined that juvenile fish suffer minimal injury and delay with the extended screens. Descaling, a measure of injury, generally occurred in fewer than one percent of the yearling chinook and four percent of steelhead.

Yearling chinook salmon averaged only two-and-a-half hours to go through the bypass; juvenile steelhead averaged five hours. Ninety-four to 98 percent of the juvenile fish exited in less than 24 hours.

In similar testing at McNary Dam, over 70 percent of juvenile fish exited in less than 24 hours. There was no detectable increased descaling on the juvenile fish guided by the extended guidance screens.

Yearlings, Subyearlings

Subyearlings are chinook salmon that emerge from the gravel in the late winter and migrate that same summer. Typically, these are the fall chinook. Chinook salmon that rear in freshwater for a year before starting their migration are called yearlings. These are the spring/summer chinook.

Turbine survival studies

Researchers also estimated the survival rate of juvenile fish that are not bypassed and must pass the dams via the turbines. Depending on the guiding efficiency of the bypass system at a particular dam, and the extent of spill, anywhere from ten to 70 percent of migrating juvenile fish might pass a dam through the turbine units.

At Lower Granite Dam, yearling spring chinook tagged with inflatable balloon tags were released into the turbine intake. The survival rate for these fish, which passed the turbine blades and were recaptured in the dam tailrace, was compared to similarly tagged fish released directly into the tailrace near the turbine discharge. Although these “control” fish did not go through the dam, they experienced the same tailrace conditions as the turbine test fish.

Over 93 percent of the fish that went through the turbines survived the passage and were healthy even after being kept for 120 hours in holding tanks. Results of the 1995 study were similar to 1994 test results.

Balloon tagged fish.

In-river vs transport migration

Researchers initiated the first year of three-year tagging studies at McNary and Lower Granite dams in 1995 to determine the relative survival rate of transported fish versus those that migrate in-river.

Passive integrated transponder, or PIT, tags and coded-wire tags were inserted in different groups of subyearling and yearling chinook. To assure that sufficient numbers of the tagged fish return as adults to provide a statistically valid sample, nearly 300,000 fall subyearling chinook were coded-wire tagged at McNary, and at Lower Granite Dam almost 250,000 yearling chinook were PIT-tagged. Some passed the dams via fish barges, and some stayed in the river passing the dams via spill, bypasses or through the turbines. Barged fish were released back into the river below Bonneville Dam.

The researchers expect to have some adult fish return data from this first year’s release by 1998. One of the keys in the two studies is that improved in-river migration conditions—flows and spill levels—are being provided as called for in the NMFS Biological Opinion, and the condition of the fish is being monitored at the dams. Scientists are hopeful that this will provide a better estimate of relative survival rates for in-river travel vs. transport travel under prescribed in-river conditions.

Meanwhile, researchers have begun gathering adult steelhead return data from juvenile fish releases made in 1992-1994. Some transported juveniles were released just below Bonneville Dam and some about a hundred miles downstream in the lower Columbia River to determine if survival could be increased with the lower site release.

Unfortunately, overall adult salmon returns to the Columbia the past couple of years were very low, and returns of test fish were much poorer than expected. There was not enough data to support hauling the juvenile steelhead the extra distance downstream to the head of the estuary.

In a third transport focus area, scientists from the Oregon Cooperative Fishery Research Unit at Oregon State University compared migration speed and survival of spring chinook transported in barges with those that had migrated in-river. The fish were released from the same area below Bonneville Dam and monitored as they migrated downstream 86 miles from the dam to the Columbia River estuary.

Preliminary information indicates no obvious trend in survival over the migration season but in two of the three paired releases more transported fish were observed in the estuary than in-river fish.

Fish travel time ranged from 30 to 80 hours, with fish released during higher flows tending to travel faster. The in-river fish generally moved faster than did the barged fish. There was no apparent correlation between migration speed and fish size. Further, most of the fish appeared to migrate directly through the estuary without stopping even to feed.

Searching for drawdown answers

Scientists continued to gather baseline information to assist the region in making decisions on reservoir drawdowns at John Day Dam on the Columbia River, and the four lower Snake River dams, as a long-term alternative for juvenile salmon passage. Information on sources of smolt mortalities in the reservoir reaches is needed along with the estimated benefit of drawdowns.

Since 1993, NMFS researchers have been evaluating the survival of juvenile spring chinook and steelhead migrating through the Lower Snake River projects. Actively migrating smolts were collected at selected sites above, at, and below Lower Granite Dam.

These test fish were PIT-tagged and released to continue their downstream migration. They were subsequently monitored at Lower Granite, Little Goose, Lower Monumental, McNary, John Day, and Bonneville dams.

Survival estimates for a large portion of the 1995 hatchery yearling chinook salmon and hatchery steelhead migrations were obtained by the NMFS researchers. Their data for 1995 shows that survival of the fish from the primary release site about 29 miles above Lower Granite Dam to the tailrace below Lower Granite Dam averaged about 93 percent for the hatchery yearling chinook salmon and 92 percent for the hatchery steelhead. Survival from the tailrace of Lower Granite Dam to the tailrace below Little Goose Dam was about 90 percent for the chinook salmon and 91 percent for the steelhead.

From Little Goose Dam tailrace to Lower Monumental Dam tailrace, survival was 94 percent and 95 percent for the chinook and steelhead, respectively. Based upon the measured survival through that reach of the river, the researchers have estimated that survival from the Lewiston-Clarkston area above Lower Granite Dam, to the Lower Monumental Dam tailrace—a distance of 93 miles—was 78 percent for the hatchery chinook salmon and 80 percent for hatchery steelhead. These estimates are relatively high compared to Snake river study data in earlier years.

Limnological data—including baseline physical, chemical, and biological data from selected shallow water habitats in Lower Granite and John Day reservoirs—are being collected to evaluate potential changes resulting from a drawdown. Sampling was conducted in 1994 and in 1995 to assess pre-drawdown conditions. If the reservoirs are drawn down, sampling would also be conducted during and after the drawdown.

More than one way to tag a fish...

There are a number of different ways juvenile fish are marked for research purposes.

The ***Passive Integrated Transponder, or PIT***, tag, is a very small (12 mm by 2.1 mm) glass tube containing an antenna and an integrated circuit chip, that is inserted into a juvenile fish’s body cavity. The tag remains inactive inside the fish for its lifetime. It contains computer data to identify the individual fish that carries it.

A PIT-tag monitoring facility located at the dam activates and reads the information from the tag as the fish passes through the facility. The data is fed into computers where it can be transformed into useful information about the fish’s migration success and habits. One limitation of this method is that, to read the PIT tags, the fish must pass within 18 centimeters—about seven inches—of the monitor.

Although considerably more expensive than other marking systems, PIT tags have several advantages. Unlike more traditional mass marking techniques, each PIT tag carries a unique code to enable identification of individual fish, so smaller sample sizes are needed to obtain good results. Also, juvenile fish can be detected as they move through the monitoring facility at a dam, and can be directed to the river or to a transport barge as needed for a particular study.

NMFS and University of Washington researchers are developing a specialized trawl containing PIT-tag detectors so that juvenile fish can be intercepted and their tags read while the fish move through the estuary on their way to the ocean. A cone-shaped net is extended between two boats to guide the fish into a PIT-tag detector/reading device attached in the tip of the cone. Fish swim into the net and through the detector, back into open water.

The researchers believe the new gear and technology is feasible for deployment at both estuary and reservoir sites as a way of providing timely and accurate PIT-tag recovery information with minimal handling impacts to the juvenile fish.

A ***Coded-wire tag (CWT)*** is a small piece of wire inserted into the nose of a juvenile fish. Coded-wire detectors can tell whether a returning adult has a coded-wire tag, but to remove and read the tag, the fish must be sacrificed. Coded-wire tags are still used for studies in river reaches where PIT-tag detectors are not yet installed. The advantages of CWTs are their low cost and good reliability.

Balloon tags contain small, deflated plastic balloons attached to juvenile test fish which are then released. The balloons gradually inflate, bringing the fish to the surface where they can be recaptured. This method is useful when you want to retrieve a fish shortly after its release. For example, in the turbine study, fish released in front of the turbines could be easily spotted and recaptured upon exit into the dam tailrace.

Radio tags are used in juvenile and adult salmon and transmit a distinctive signal, or frequency. The fish are tracked using radio antennas, which can be mounted on the dams, in boats, or even on a truck. There are a limited number of frequencies allowed for the radio tags, and only one is assigned per fish. A radio-tag study might therefore only look at ten fish. But the advantage is in mobile tracking ability, with signals that can be read up to about a half mile away. Because the tags have batteries and limited life, this method is not used to monitor juvenile to adult survival.

For *hydroacoustic monitoring*, instruments called “transducers” are strategically placed to record movements of objects in the water, and send those messages to a computer. Researchers are able to deduce whether large or small numbers of fish are attracted through various passage routes.

National Research Council Releases Salmon Report

The National Research Council (NRC), the research branch of the National Academy of Sciences, has released a report titled *"Upstream: Salmon and Society in the Pacific Northwest"*.

The report, released in November, delivers several key messages:

- The salmon problem will take a while to correct; it did not just happen over the past few years or the past few decades.
- There is no magic bullet solution. The salmon problem has many causes, all of which must be addressed and most of which stem from human population growth. All users of the natural resources in the Columbia River Basin will need to contribute if we are to achieve success in rebuilding salmon populations.
- Natural environmental causes, such as changing ocean environment and weather patterns, must be considered in strategies for salmon restoration.
- The institutions currently in place in the Pacific Northwest have so far not solved the salmon problems, and have not been successful in preventing salmon declines in many stocks.

The report responds to language in a 1992 Congressional appropriations bill which directed the National Academy of Sciences to study salmon stocks in the Pacific Northwest, the causes of declines in those stocks, and options for counteracting the declines. The National Research Council formed a committee of 17 independent volunteer scientists and experts to work on the report. The Committee compiled information on seven Northwest salmon species and held public meetings in the region to hear from interested parties.

All recovery aspects important

The report urges the region not to focus all its resources for salmon restoration on only one aspect of the problem, such as harvest or the dams. Only by looking at an array of corrective actions addressing all aspects of the fish habitat and life-cycle can we hope to improve recovery chances for the salmon, the study says.

The report stresses the importance of a genetically diverse salmon population. Since salmon tend to return to their natal areas to spawn, and because those areas are relatively small and contained, genetic variety becomes more important. In the event of a catastrophic event in the spawning area, a population is more likely to survive if there is a diverse gene pool, increasing the likelihood that some fish could successfully defend against the catastrophe.

Eggs and Alevins

The report emphasizes one factor in wild salmon declines not readily obvious to most of us—the large number of hatchery fish that are released each year to join wild populations. Hatcheries began to appear in the Pacific Northwest in the late 1800s to supplement wild populations. As the basin became more developed in the twentieth century, more hatcheries were built to mitigate for adverse impacts on salmon. Few realized that towards the end of the century, hatchery fish would outnumber wild fish in some areas by nearly three to one.

Another critical factor is the increased pressure on the natural environment from growing human populations. Impacts of forestry, agriculture, grazing, industrial uses, commercial, residential and recreational development and flood control, can increase soil erosion, reduce woody debris in streams, raise water temperature, add contaminants, and affect water flow and availability, all of which affect salmon survival.

With the combination of weakened genetic make-up from the proliferation of hatchery fish, and a habitat that has become less and less friendly, defensive mechanisms of the salmon populations are low at a time when needed most.

The report offers some concrete suggestions for improvement that would allow salmon to recover and perhaps thrive in today's environment.

One of these is to coordinate habitat protection on a scale appropriate to the salmon life cycle, such as evaluating all of the needed improvements in a watershed area or other appropriate division of habitat. Another is to adapt hatchery management practices to emphasize genetic and population diversity in salmon by focusing on rebuilding natural populations, and using hatcheries for studying salmon survival.

Columbia/Snake River dams

Dams throughout the Columbia Basin are identified as a significant factor in declines of salmon stocks in the basin. The study lists a range of adverse effects of dams such as loss of upstream spawning areas at dams with no fish passage, change in the quantity and timing of water flow and flow velocities, and change in water chemistry and temperatures. Reservoirs behind the dams can alter or eliminate extensive spawning and rearing habitat areas. Many water diversions for irrigation lack protective fish screens, adding to juvenile fish loss. And although 90 percent or more of the juvenile fish may migrate safely past a dam, the cumulative effects of multiple dams adversely affects salmon survival.

The NRC report recognizes the controversy surrounding the effects of dams and how best to mitigate them, especially in the Columbia River Basin. The committee reports that natural river level drawdowns of the four lower Snake River dams could improve conditions for salmon in the lower Snake River. However, the study notes the extent to which this would help bring back salmon runs is unknown, and the expense and impacts would be enormous.

The report sees transportation of fish in barges and trucks as “the most biologically effective and cost effective approach for moving smolts downstream” until we have more information on passage systems under study, and better research on the effects of transport versus other options. However, transport should be used in conjunction with other fish passage options. To insure that not all of the fish are entrusted to one passage route, in-river passage via bypass and spill should also be a part of the program.

The report cautions against allowing any new dams to be constructed, and recommends that when existing dams come up for relicensing, they must show they have adequate fish passage facilities.

While recognizing the importance of salmon fishing in the Pacific Northwest, the report recommends some changes in fishery management. The number of fish needed to return to spawning areas—“escapement”—should be considered in fishery management rather than looking at the number of fish allowed for harvest. Maintenance of genetic diversity must be a factor.

The need for a Scientific Advisory Board is seen as a way to address the problem of needed research and limited available funds. The committee recommends an independent, multidisciplinary scientific advisory board be established to ensure the most productive use of funds to address the most critical questions in a timely manner.

“Upstream” drives home the complexity of the salmon problem and the need to come to regional agreement on a comprehensive plan for restoration. At the NRC public briefings on the report in early December, it appeared that the region is not ready to simply pick up the report and put its specific recommendations into action. Although the report may represent the best options from the committee’s viewpoint, it may not reflect the values and desires of the many different factions in the salmon picture.

Regional System Operation Review Completed

The final Environmental Impact Statement (EIS) which analyzes the impacts of various alternatives for operating the Federal Columbia River Power System for all uses, has been released. The Corps of Engineers, Bureau of Reclamation, and Bonneville Power Administration jointly led the effort in preparing the System Operation Review (SOR) EIS.

The EIS represents the culmination of five years of intensive effort by these agencies along with the National Marine Fisheries Service, US Fish and Wildlife Service, and National Park Service as cooperating agencies, and with participation by state fishery agency and tribal representatives.

The SOR was initiated in anticipation of future federal decisions on key power agreements—the Pacific Northwest Coordination Agreement (PNCA) and the Canadian Entitlement Allocation Agreements (CEAA). With the Endangered Species Act listings of three species of Snake River salmon in 1991 and 1992, the study began to place more emphasis on river operation for the benefit of the listed fish.

The preferred alternative in the EIS reflects operational measures contained in the National Marine Fisheries Service Biological Opinion on Snake River salmon, and the US Fish and Wildlife Service Biological Opinion on Kootenai River white sturgeon species, now also listed under the Act.

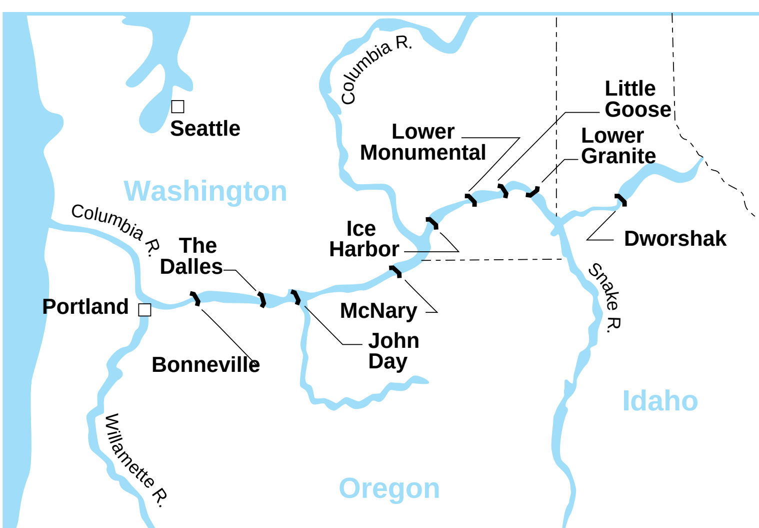
After 30 days following the release of the EIS, the three co-lead agencies that have joint responsibility for operation of the system, may issue records of decision on implementation of any actions analyzed in the EIS. The records of decision need not directly reflect the preferred alternative.

The preferred alternative in the EIS would continue such measures as storing water in upstream Columbia and Snake River dams during the fall and winter months, so that more water can be released for juvenile fish in the spring and summer migration seasons.

Spilling more water and juvenile fish over dam spillways is incorporated in the preferred alternative. The Juvenile Fish Transportation Program would continue, although in high flow years a smaller percentage of the fish would be transported.

Options for a regional Forum for providing tribes, citizen groups and fish and wildlife agencies an increased role in helping shape decisions on system operations, were analyzed in the SOR EIS. The preferred alternative does not include a specific Forum recommendation because there was no regional consensus, and little public comment, on any of the options.

If you are interested in any SOR documents, including the Final EIS, the document request line is 1-800-622-4520. The information line is 1-800-622-4519. The SOR Final EIS Main Report is 538 pages, two volumes, and the EIS Summary is 56 pages. Appendices, from volume A to volume T, add thousands of pages.



Corps Salmon History is here

"Saving the Salmon, A History of the US Army Corps of Engineers' Efforts to Protect Anadromous Fish on the Columbia and Snake Rivers" is now available. If you would like a copy, or have already requested a copy and have not received it, please notify Dr. Bill Willingham, NPD Historian, P.O. Box 2870, Portland, OR, 97208-2870.

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